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A VARIABLE ANAMORPHIC EYEPIECE FOR USE WITH THE ZOOM 70 MICROSTEREOSCOPE

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1.0 INTRODUCTION

This proposal presents the technical details for the design and fabrication of a matched pair of variable anamorphic eyepiece attachments for the [redacted] Zoom 70 Microstereoscope. The STAT proposed stereomicroscope eyepiece adapter will provide the necessary rectification over the small fields of view which are covered at the magnifications required. The variable anamorphic lens will provide a variable 3X distortion in X and Y. The same basic anamorphic adapter is utilized to provide four ranges. A 10X eyepiece will provide 5X to 15X, a 15X eyepiece will provide 7.5X to 22.5X, a 20X eyepiece will provide 10X to 30X, and a 30X eyepiece will provide 15X to 45X differential anamorphic ranges. No modifications to the Zoom 70 power pod is required when inserting and using the anamorphic adapters. Each eyepiece adapter is rotatable through 360 degrees, thereby providing complete freedom in the orientation of the anamorphic distortion. The maximum extension of the present power pod receptacles will be 4.5 inches. The optical center line will be offset so that the original Zoom 70 eye separation range can be achieved.

2.0 DESCRIPTION OF BREADBOARD

In order to establish the feasibility of the proposed system a breadboard was set up and evaluated. The breadboard utilized two 100mm focal length cylindrical lenses which were previously utilized in a successful anamorphic system for a projector which recorded photographic subtitles on cinemascope motion picture film. This system reduced an area four inches in diameter 10 times with a 2:1 anamorphic squeeze.

The breadboard (Figure 1 and 2) utilized a 40mm microscope objective to project a USAF test pattern through the two cylindrical lenses. A 3X anamorphic scale change was achieved and no color, aberration, or distortion was evident during visual inspection. A resolution of 200 lines per millimeter was resolved.

Similar lenses have been scaled down and utilized in the proposed design.

3.0 ANAMORPHIC OPTICAL SYSTEM

An optical system that will give different magnification along X and Y axes is illustrated in the following sketch.

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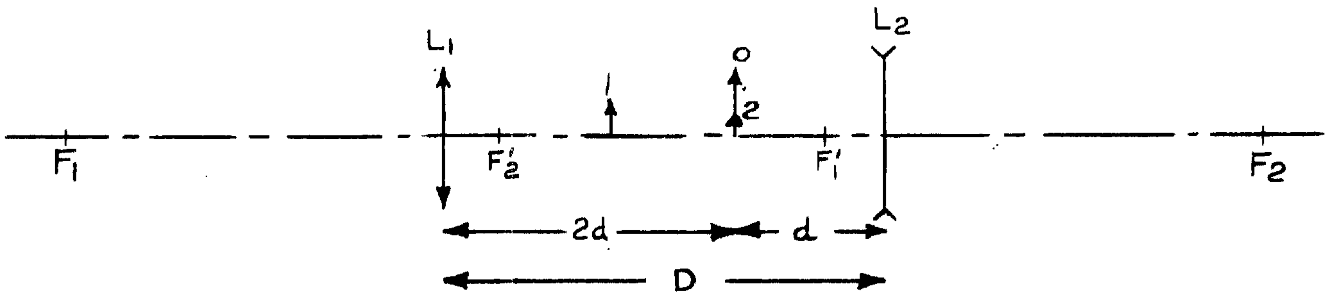

Figure 3 ANAMORPHIC LENS SCHEMATIC

L_1 is a positive cylindrical lens, preferably a plano convex lens indicated by L2 is a negative cylindrical lens, preferably a plano concave one, indicated by . Both lenses are of equal focal length. The focal points of the lenses are indicated in the sketch.

The original image projected by the microscope objective lens will be the arrow 0. By the interposed cylindrical lens L_1, zero will be projected into another plane and appear as a smaller arrow 1. This image is taken up by the negative cylindrical lens L_2 and imaged back to the original image plane as a still smaller arrow 2.

This action takes place in a plane which is defined through cylinder axis of the two cylindrical optical elements. The cylindrical axis of these two elements must be parallel. Since there is no optical effect in a plane perpendicular to the thus defined plane, we have different magnifications along the X and Y axes. A circle viewed through this arrangement will appear as an ellipse, a square as a rectangle. If no optical effect is desired the two cylindrical elements are positioned such that the cylindrical surfaces touch each other. In this case the two lenses represent a plano parallel plate with no effect upon the magnification of the system.

The ratio in which the magnification M_x and M_y differ is a function of D, (the distance between the cylindrical lenses). In order to keep image 0 and image 2 sharp in the same plane, L_1 must move a distance 2d. L_2 must move d in the opposite direction. The direction of the cylinder axis of both elements must be kept parallel during the motion.

By turning the whole assembly around the optical axis, the direction of highest magnification will change. Any orientation for the variable magnification may thereby be selected.

4.0 DESCRIPTION OF ANAMORPHIC ADAPTER

4.1 OPTICAL DESCRIPTION

Figure 4 shows the proposed design of the Variable Anamorphic Adapter. Cylindrical lenses of 75mm focal length are arranged in accordance with the previous discussion, illustrated in Figure 3. This assures the required action to provide a 3X anamorphic range. The positive lens travels two inches into the microscope tube, while the negative lens moves one inch in the direction of the eyepiece. In order to compensate for the field loss caused by the anamorphote cells and fill the field at the eyepiece for the lower magnifications, a relay system is inserted between the negative lens and the eyepiece. This relay lens provides an additional 1.5X magnification. Figure 4 shows a folded mirror system to decrease the over-all length of the adapter. However, a mirror system will provide an inverted image at the eyepiece. If this is not desirable, Figure 5 illustrates a porro-prism image erector which could replace the mirror system in order to provide a correct image at the eyepiece.

4.2 MECHANICAL DESCRIPTION

Mechanically the whole system can be rotated around the optical axis by means of a lever to align axis of maximum magnification to X or Y. The position of the plane of maximum magnification can be seen from the position of the operating lever. This lever will be located on the image erector housing.

Another knob also located at the erector housing controls the squeeze of the anamorphic system. By this knob tube T_2 is rotated thus moving $cell_1$ and $cell_2$ in opposite directions to change the distance between the cylindrical lenses. The knob will be coupled to the tube. Helical slots with a 2:1 pitch ratio will maintain the correct lens position throughout the anamorphic magnification range. Two pins in each cell for L_1 and L_2 reach through the helical slot in tube T_2 and straight slot in tube T_1. As tube T_2 is turned, (while T_1 is kept in place) the two cells will follow the helical slot and move in opposite direction to give the anamorphic effect. The straight slot in tube T_1 will keep the two cells and thus the two cylindrical lenses parallel.

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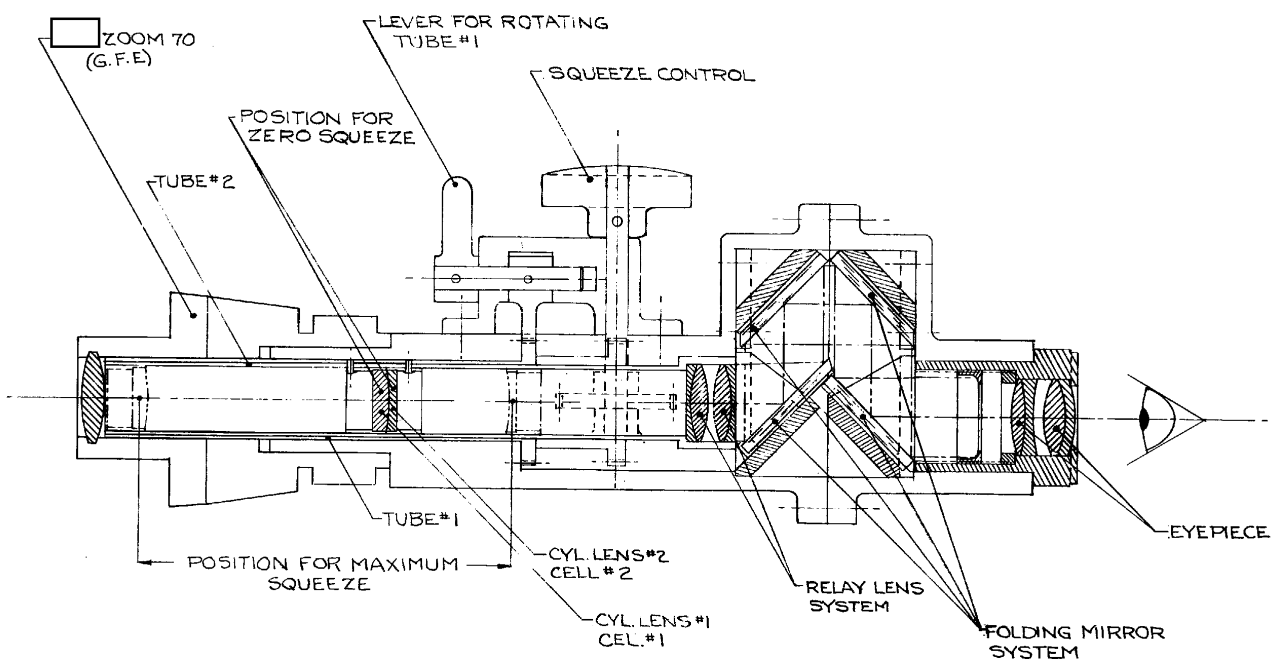


THEORY OF OPERATION
TURNING TUBE #2 INSIDE TUBE #1 CONTROLS THE SQUEEZE RATIO.
TURNING TUBE #1 ALIGNS TWO (2) MAGNIFICATION AXES WITH VIEWED OBJECTS

Figure 4 VARIABLE ANAMORPHIC ADAPTER

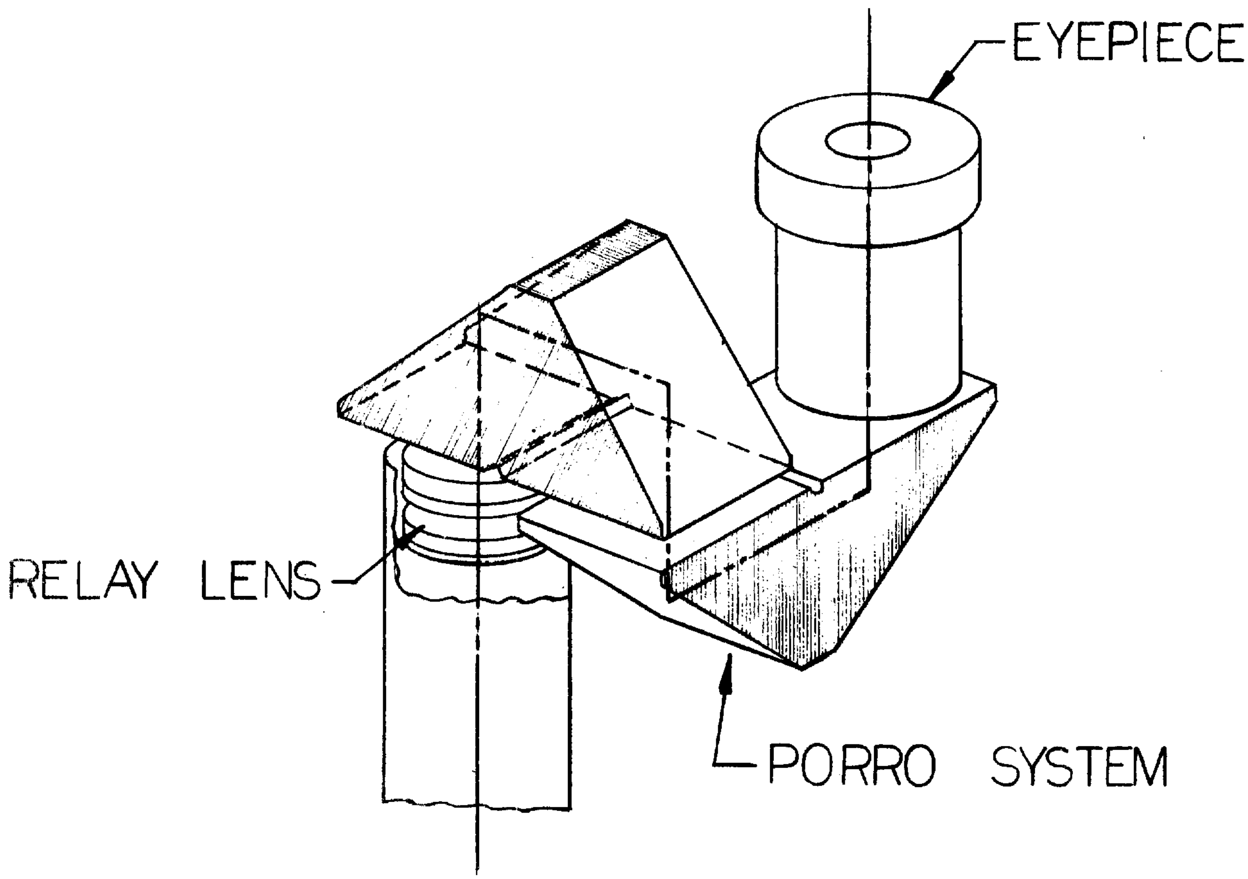


IMAGE ERECTOR

Figure 5

5.0 EYEPIECE OPTICS

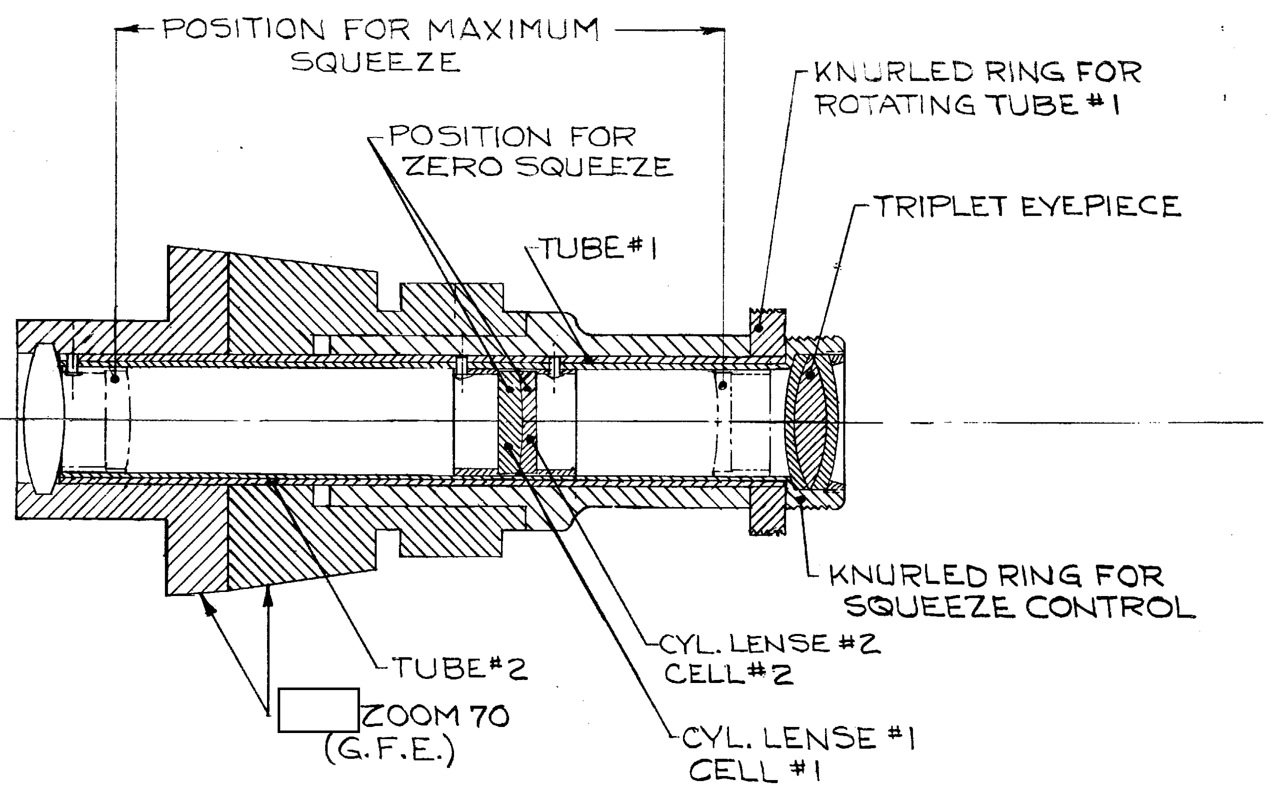
The basic anamorphic adapter using two 75mm focal length lenses will be utilized with a 1.5X relay lens and folded light path in order to fill the exit pupil through the anamorphic magnification range. A total of four eyepieces and magnification ranges will be provided. The 10X and 20X eyepiece presently available with the [redacted] Zoom 70 Stereomicroscope will be applicable. Two additional eyepieces, one 15X and one 30X, will be provided. The following operational ranges will thereby be possible. STAT

EYEPIECE	MAG. X	MAG. Y	ANGULAR "X"	FIELD "Y"
10X	10X	15X → 5X	±21°	± 8°
20X	20X	30X → 10X	±21°	±21°
15X	15X	22.5X → 7.5X	±21°	±11°
30X	30X	45X → 15X	±21°	±21°

The 10X eyepiece presents a problem at the lower magnifications in normalizing the field of view at the exit pupils. With the 10X eyepieces an oval to round field of view occurs very quickly at a 1:1 squeeze ratio, and at the 3:1 range presents a diameter along Y axis of approximately one-third of the full field. This condition starts occurring with the 15X eyepiece at an anamorphic squeeze of 1.5X and presents a view in one axis of approximately two-thirds the full field at the full 3:1 anamorphic range. This condition is probably acceptable with the 15X eyepiece, but may give the operator some difficulty at the lower ranges of the 10X eyepiece.

6.0 SIMPLIFIED APPROACH

The sole purpose for the relay lens and folded optical system is to provide an improved field at the eyepiece which does not visually accentuate the anamorphic action of the field. Figure 6 indicates a simplified system without the relay lens and folded path. The system also incorporates a 3:1 anamorphic action and will provide a magnification range from 5X to 30X with properly selected eyepieces. However, the foreshortening of one eyepiece field of view with respect to the other occurs at higher magnifications than a system with a relay lens. It is, however, a much lighter, simpler, and economical approach to the problem, if the operator would not consider out-of-round fields of view too serious a detriment.



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THEORY OF OPERATION

TURNING TUBE #2 INSIDE TUBE #1 CONTROLS THE SQUEEZE RATIO.

TURNING TUBE #1 ALIGNS TWO (2) MAGNIFICATION AXES WITH VIEWED OBJECTS

Figure 6 ANAMORPHIC ADAPTER - ALTERNATE CONFIGURATION